American Journal of Public Health
Official Monthly Publication of the American Public Health Association
Vol. VII JUNE, 1917 No. 6

MILITARY SANITATION IN THE PRESENT WAR.

THORNDIKE SAVILLE, C. E.,
Harvard University, Cambridge, Mass.

PREFACE.

The present war has produced only two small books dealing with military hygiene and sanitation. They present briefly and concisely many of the solutions to perplexing problems which war conditions have caused, and indicate many new phases of sanitary endeavor and accomplishment.

One of these books—"Sanitation in War," by Major Lelean of the British Medical Corps, is a compilation of nine lectures given during the war at the R. A. M. College. These treat of the generalities of war-time sanitation and consider such topics as physical fitness of soldiers, anti-typhoid inoculation, hygiene of the march, water supply, rôle of insects, etc. It is, so far as the writer is aware, the best short manual on sanitation which has yet appeared in the English language.

The other book was published only last year (1916) and is entitled "La Pratique de l'Hygiene en Campagne" by Andre Tournade of the French Sanitary Service School.

This book of two hundred pages is quite detailed, and considers a great variety of matters in very brief style. It is the most complete, and yet brief, handbook on the general subject of military hygiene and sanitation which has yet appeared. It is full of many valuable hints and advice growing out of experience in the present war.

Neither of these books are published in the United States (although "Sanitation in War" is handled by Blakiston, Philadelphia) and no translation of the "Practique de l'Hygiene" has yet appeared. On account of the valuable information, of such immediate utility just now to sanitarians in the United States, the writer has made brief abstracts of the more useful and novel features of these two books. The French book especially has been quite fully abstracted, omission being made chiefly of material concerning medical rather than sanitary practice.

The intention has been to give only such matter as is likely to be new to American readers and not readily found in current treatises. For this reason common practices in military sanitation have been deliberately omitted, and the following notes do not pretend to be a complete exposition of the subject. This article has been prepared in the hope that some new ideas from the war zone may be brought to the attention of American sanitary officials for use in the present crisis. For more detailed comment readers are referred to the original sources.

INDEX.

MILITARY SANITATION IN THE PRESENT WAR.

1. Baths [*F*].*

THE author states that wherever men are encamped for any length of time, baths should be installed with both hot and cold water. An indispensable adjunct of these is said to be a hair dresser (coiffeur) who "will complete the toilet of the men by trimming their hair"!

The Tub.—Where conditions must be most primitive small vats or tubs that happen to be at hand may be used. The water is warmed on the cook fire and the men are brought in groups of ten, made to undress and are scrubbed. In especially unfavorable conditions in cold weather the bathing may be done in the stables where the heat from the animals will maintain a comfortable temperature.

Shower-baths.—A unique arrangement has been devised for the vicinity of the trenches (Figure 1). More elaborate arrangements are provided for permanent encampments. There are also in service some bath trains, fully equipped for sterilization of clothes, bathing of men, etc.

2. Battle Field Sanitation [*F*].

This comprises:

(1) *Burial of corpses*, and amelioration of conditions arising from previously imperfectly buried bodies. This task is important and influenced by the condition of the country, the geology of the place, and the regard for pollution of underground waters.

(2) *Burial of human corpses with quicklime* and incineration of animal corpses and general organic filth.

(3) *Disinfection of polluted wells.*

(4) *Disinfection of field hospitals.*

3. Beds (Temporary).

The French have found that two wooden horses placed at each end, a woven brush or reed matte placed between and a mattress on top furnish quickly available emergency cots.

4. Bivouac [*F*].

During bivouacs the Sanitary Service is concerned in the construction of shelters. It is stated that several

* Matter taken from "Practice de l'Hygiene" is prefaced thus [*F*]. That from "Sanitation in War" by [*B*].

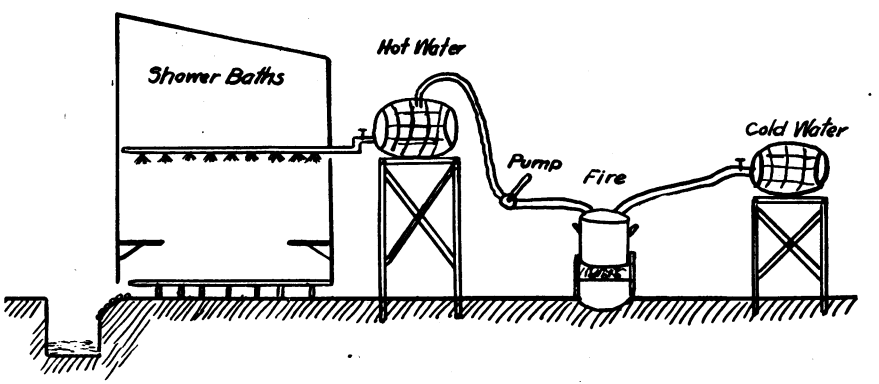


Figure 1

sheets of newspaper placed inside the shirt makes excellent insulation against cold, especially if it is impossible to have fires.

5. Burial of the Dead [*F*].

The disposal by burial of the enormous numbers of dead on the field of battle presents no inconsiderable problem. The French have promulgated the following rules for burial in ground recently evacuated by the enemy:

A convenient site is chosen, as near as possible to where the men have fallen. Corpses should not be buried near farms, sanitary structures, roads, rivers, water courses, or in places likely to be flooded. A silicious or calcareous region, dry, permeable, slightly sloping and studded with trees is the best, if available.

Unless specifically disapproved, common graves, holding 100 bodies, are used. Two principles should be observed in digging the trench: (1) Easy access of air, and (2) provision for circulation of ground water. These principles must be observed to promote bacterial growth and hence rapid decomposition. By the same token, use of antiseptics on the bodies is ordinarily forbidden. All clothing is removed from the bodies before burial, if decomposition is not too advanced.

The ditches shall contain only a single row of corpses, and shall be of the following dimensions: 1.60 meters deep, 30 meters long, 3.5 meters wide (In English measure roughly 5′ deep, 100′ long, 11′ wide). The main trench is drained by a small ditch in the bottom, about 1 foot deep and lined with branches. stones, etc.

At the highest point of the burial ditch, an opening is left, to serve as a sort of chimney for the gases of putrefaction. It is well to cover the corpses first with branches, then the useless clothes, then charcoal, then turf, then earth; the whole forming a depth of three to five feet, and making a low mound.

The disposal of the dead lying between the enemy's lines and the first trenches, and of those dead in the trenches, is a difficult problem, and one often insurmountable. Putrefaction of the bodies in the open air is not uncommon. So far as possible bodies are brought in under cover of night, and properly disposed of.

When the burial of bodies becomes impossible, or when in advancing over new territory, recently interred bodies are uncovered, it is best to treat them at once with an abundance of quicklime, or ten per cent. ferric sulphate. Better yet to treat with a 1/20 creosol or formalin solution. A chloride of zinc solution, followed by ferric sulphate produces anti-septic, mummifying and larvicidal conditions.

One cannot help but join in the British lament over the unreasoning sentiment which thus far has prevented the incineration of dead bodies. If popular feeling were such that the bodies of those slain in battle could be incinerated, a vast deal of time and trouble would be eliminated, and much more sanitary conditions achieved. In this connection it is interesting to note that reports continually reach this country concerning the rendering of dead bodies by the Germans. The horrified American press has devoted

considerable space to the activities of the "Corpse Utilization Establishment (Kadaververwertungsanstalt) at Evergnicourt." It it alleged that the dead bodies are fastened in bundles of three or four with iron wire and despatched to the rendering establishment. Here they are rendered, the products being a lubricating oil won from the fats, and a compressed "stick" which is used as fodder for hogs. The German government has denied that human bodies were thus treated, the Allied governments have affirmed it. In any event such a method of disposal would seem as satisfactory as burial of the dead in a common grave where the bodies may not only decompose and render foul the ground and water supply, but also interfere with subsequent military operations.

6. Cantonments [*F*].

The hygiene of a cantonment comprises the following preliminary factors:

1. *A sanitary survey*—conducted by a doctor, and including the epidemiological history of the place, quality of the water, health of the inhabitants, etc.

2. *An estimation of the capacity of the place* and its provisions (sanitary and otherwise) for receiving men and horses.

The three main considerations before the sanitary officer after occupation of the cantonment are:

1. *Protection of the Ground.*—The first necessity is the provision of temporary latrines, that the men may not pollute the soil or gardens or create offenses near houses. The regulation latrine ditches should be made as soon as practicable. Care should be taken to prevent stagnant pools of urine or wash water in the ditches. The disposal of organic filth and refuse from kitchens and slaughtering places is best accomplished temporarily by treatment with quicklime. This indeed seems the panacea most used by the French for a considerable variety of sanitary ills. They use it to a much greater extent than either the British or Americans. Stable refuse is carefully carted at least a kilometre distant and in a direction opposite to the prevailing winds. There it is dumped on the fields. Surface drains should be among the first permanencies of any camp.

2. *Provision for Pure Water.*—The general rule is to consider all water polluted, and to sterilize it. Signs are posted stating "Dangerous Water" or "Drinking Water." Such signs as "Rinsing Water" or "Wash Water" are absolutely forbidden. Sterilization is accomplished by hypochlorite of lime or permanganate of potash. The British do not favor the use of the latter.

Secondary cares are measures taken to allow men to perform their toilet and to wash their clothes. Indeed the French seem peculiarly concerned lest the men be not able to shave and get a hair cut. This care for the individual comfort of the soldier is a matter of detail about which both French and English officers devote an increasing amount of time and thought.

7. Care of Quarters [*F*].

The use of whitewash is apparently very extensive in the French army.

Not only are all temporary outposts, stables, barracks, etc., kept whitewashed, but elaborate methods have been devised for the preparation of screened partitions for field hospitals or barracks, which consist essentially of a linen cloth fastened on a wooden framework and whitewashed. A sanitary and translucent (but not transparent) partition is thus obtained. The whitewash is most successfully applied when there is added to it 1 to 2 grams of alum per litre, as this facilitates adhesion. Whitewashed linen mounted on framework serves many uses under front-line conditions, as for barriers, screens for privies, screens for officers' quarters, the foundation of barricades, litters, etc.

8. Cooking.

The great problem at the front is to make cook fires or to cook without producing smoke. The French mention only that they use charcoal or coke in a brazier for this purpose. These the soldier uses for cooking and heating. The French also use so-called "solidified alcohol" prepared by mixing 100 cc. of denatured alcohol with 30 grams of a special soap.

The English have now in use a travelling kitchen of the "heat retaining" type. This consists of heat insulated ovens and compartments arranged around a central furnace, the whole mounted on two wheels. It is drawn by two horses, weighs 2,400 lbs., and cooks for 250 men and officers. Before starting the march the food is placed in the ovens, etc., the fire is lighted and vigorously stoked for over an hour. On starting the march the fire is drawn or damped. Cooking proceeds in the insulated compartments during the march.

9. Diseases of Armies [*F*].

Typhoid.—The prevention of this former scourge of armies by compulsory vaccination with anti-typhoid vaccine is so well understood and so successfully practised in the United States Army that few data are needed here. The British have used two injections at ten-day intervals, one of 500 million dead bacilli and the second of 1,000 million. The French have found that two injections does not always protect, and use four injections at intervals of seven to ten days. The numbers of bacteria per cc. used in the French vaccines is not stated, but the first dose comprises ½ cc. of vaccine, the second 1 cc., the third 1.5 cc. and the fourth 2.0 to 2.5 cc. Only men in good health are inoculated, and they are given one day off duty following each injection. The French give a .5 centigram aspirin tablet one to two hours after the injection. If local reaction is excessive the English give 30 grains of chloride of calcium (or 15 grains calcium lactate) just before and six hours after the inoculation.

Diarrhea and Dysentery.—The predisposing conditions in the present war are said by the French to be: the long stationing of large numbers of troops in the same place with consequent severe infection of the ground and water; the diet having too much meat, or, in summer, the ingestion of too many green vegetables by men who

are careless of their alimentary hygiene; the cooling of the stomach consequent upon careless removal of the flannel belt or from lying on damp ground; and sometimes also the ghastly conditions in the trenches.

The expressions "diarrhea of the trenches" and "dysentery" are used loosely to cover many intestinal infections, from typhoid, or more often paratyphoid, through gastric diarrhea, enteritis and hemorrhoids, to true dysentery. Only bacteriological examination makes differentiation certain, and such examination should always be made if possible, that proper measures of control of the infection may be taken. The chief precaution is to thoroughly disinfect all discharges from patients having diarrheal affections.

Trench Jaundice.—This is one of several names given to an apparently new disease which is rife in the trenches. "It is characterized by sudden onset of malaise, intense muscular pain, high fever for several days, followed by jaundice, and is frequently accompanied by subcutaneous hemorrhages and other complications." It is claimed that Dr. Noguchi of the Rockefeller Institute has demonstrated the germ of this disease in rats, both those infesting the trenches and those at some distance from them, and that he attributes the spread of the disease in some way to the presence of rats carrying the germ.

Cholera.—This disease is endemic in certain regions controlled by the Central Powers and precautions must be taken by advancing Allied troops. All prisoners are subjected to careful scrutiny, and if suspected, to bacteriological examinations and isolation. General precautions are those of sanitation of the trenches and disinfection of excreta in latrines, trenches or elsewhere. A careful diet, free from fruits and uncooked vegetables, with sterilized water, are additional safeguards and prophylactic measures. The Germans have successfully used anticholera vaccination in the present war, and the French are about to adopt it in suspected regions.

Typhus.—This disease being spread by the body louse or tick, the following measures for its suppression are in use by the French:

1. Disinfection of cantonments abandoned by the enemy, and medical supervision of prisoners for suspected cases. The disease is rife in both the German and Austrian armies, and as troops are transferred from place to place, the utmost care is necessary to prevent its introduction.

2. Community measures. Inspection of premises and personal effects of the soldiers; installation of stations for disinfecting clothing of vermin; installation of shower baths.

3. Precautions for suspects. Caresul delousing of hair and clothes by fpecial contrivances; isolation of the suspect or patient; enforcing absolute asepsis by means of special clothing, etc., on all the medical personnel; general sanitary precautions to isolate the buildings containing suspects and patients.

Removal of lice from head is effected by an ointment of kerosene and olive oil, equal parts, rubbed on head and washed off in 24 hours, also ben-

zene, kerosene, or 10 per cent. acetic acid alone are effective. Lice in clothing are removed best by powders, one of which is of 2 per cent. iodoform and creosote and 96 per cent. naphthaline. The young are destroyed by smearing seams with a grease of mineral oil 9 parts, soft soap 5 parts to water 1 part. Steaming or heat treatment is also efficacious.

Directly contagious diseases, as measles, scarlet fever, diphtheria, cerebro-spinal meningitis have all been prevalent in the armies in the field. Protective measures are diagnosis, isolation, removal of the patients and disinfection of premises.

Venereal Diseases.—An increase in these diseases has been noted during the war. Infection occurs not at the front, or at the temporary halting places, but in soldiers on leave in the Interior and at the Depots. Clandestine prostitution is held to be responsible, combined with the letting down of the soldiers' moral tone with relief from trench warfare and the knowledge that he soon must return to it. Active measures of education by doctors under the auspices of the Academy have been inaugurated. Meanwhile the usual measures are taken to combat these diseases in the army. The equivalent of two army corps are said to be continually incapacitated from these diseases.

10. Disinfection [*F*].

For dry antiseptics the French use chloride of lime (as a deodorant), ferric sulphate (to prevent fermentation) and quicklime (to destroy organic matter).

Formalin solutions are commonly used as body disinfectants in washing, etc. Of other antiseptic solutions only the following are considered satisfactory for field use.

Chloride of Lime.—This is prepared by adding little by little 100 grams of chloride of lime to a litre (=1 quart approx.) of water, then diluting with water to 10 times the volume. The strength of this antiseptic is considerably increased when heated. The solution attacks all metals.

Corrosive sublimate ($HgCl_2$) one to one thousand. The addition of 2 grams of sea-salt per litre (quart) adds to the efficacy by hindering the coagulation of albumen.

Heavy coal-tar oils in emulsion with water in proportion of 50 to 100 per 1,000 constitutes primarily deodorants and is especially valuable in the urinals.

Disinfection by steam or liquids is made of all bed clothing and linen after use by a patient, even though the patient has the same disease. This is done to prevent secondary infection as from broncho-pneumonia, grippe, etc., when the original infection may have been measles or scarlet fever. It is interesting to note in this connection that the French recognize broncho-pneumonia as a contagious disease.

For sterilization of dejecta, prolonged contact with 5 per cent. solutions of copper sulphate, 2 per cent. or 3 per cent. creosol, or 4 per cent. chloride of lime is used.

The British use for field disinfection a portable Thresh steam disinfector—capable of sterilizing 60 blankets at 100° C. The standard disinfectant used in the field is Liquor Cresoli

Saponatus, having a carbolic coefficient of 12. It forms a stable emulsion and is used in proportion of one and one-half ounces to the gallon of water. Carbolic acid and formalin are also used in proportion of eight ounces of either per gallon of water.

Disinfection by formaldehyde and sulphur dioxide is widely practiced. The processes are similar to those used in the United States and will not be described. In these ways disinfection is made of all hospital wards after contagious cases, including rooms, halls, vestibules, etc.; also of ambulances which have carried contagious cases.

For disinfection in the dry, use is made of either of the following arrangements:

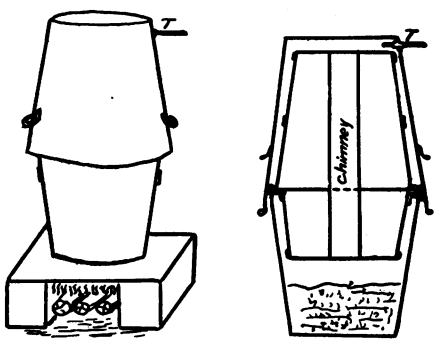


Figure 2

The first (Figure 2) consists merely of two conical parts, one inverted over the other. A closed chimney passes through the center and a thermometer opening is left at the top. The clothing or other things to be sterilized are placed around the chimney and a temperature over 100° C. is attained. The temperature recorded by the thermometer, however, is not that which obtains in the interior of the cones and it would be better to insert it half-way down the cone.

A more elaborate arrangement (Figure 3) is that of Doctor Bordas,

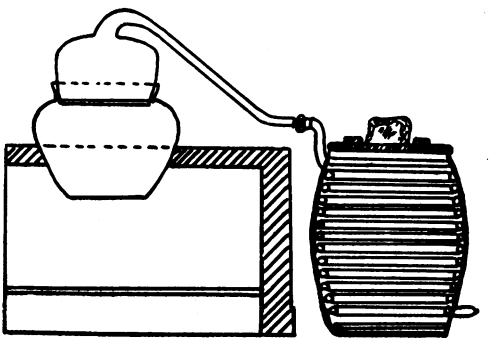


Figure 3

consisting of a retort filled with water. The steam generated passes through spiral lead pipes coiled about the inside of a wooden cask. Material to be sterilized is placed in the inside around a cylindrical log of wood which is stuck up through the center. When ready for use the log is withdrawn, the cover made tight and steam turned on. Temperatures of 106 to 108° C. are attained.

11. Excreta Disposal.

In General.—For more or less temporary encampments the shallow straddle trench has found favor both with French and British. These are essentially as used in this country on maneuvers. It is specifically stated by the English that dirt should be heaped on both sides of the trench to force the men to straddle. Otherwise the ground nearby becomes foul with

urine and the men stand farther and farther away from the trench.

The English have now come to use soakage-pits for urine. The pit, a three-foot cube, is excavated, and the soil at the bottom is loosened. The pit is filled to nearly the top with graded stones. When a suitable height is reached funnels are inserted in each corner at a convenient height. In this way fouling of the surface is eliminated and access of flies to the urine is prevented.

In the Trenches.—Here the safe disposal of excreta is a great problem. Space is at a premium, and the frequent digging of shallow straddle pits often impossible. The French excavate a deep pit, well behind the trench line. The pit is constructed parallel to the trench line and space is left for additional pits as shown dotted in the diagram, Figure 4. The communication is by means of a lateral trench some fifty feet long at right angles to the main trench. The passage way must slope *from* the main trench to prevent flooding of the latter with excrement in case of heavy rains. The pit is dug to a depth of two and one-half or three metres (8–10 feet). Around the pit is constructed a firm platform, with well-defined places for the hands and feet of men using it, and triangular openings. When the pit is three-quarters full, it is covered with brush, some coal tar deodorant is put in, and another pit is dug in front. After use the men should be instructed to throw dry earth on the dejecta. Three times a day some disinfecting and deodorizing substance should be thrown in.

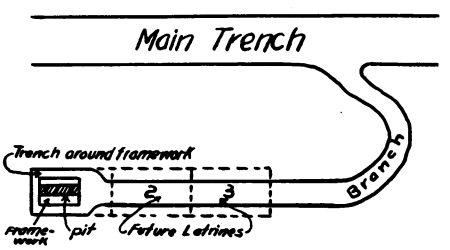


Figure 4

The French also—under some conditions—provide troughs in which liquid disinfectant is kept. The excreta are deposited here, and kept until disinfecting action has progressed to a point where they may be dumped in a pit without offense.

The English have not found pits to work well in the trenches, due to frequent flooding. They therefore place buckets in bomb-proof dug-outs. The buckets are removed by the relieved troops, who bury the contents and bring the buckets with them on their return.

An unofficial method of disposal is said to have consisted in placing excreta in empty tins and tossing them into nearby enemy trenches. Reprisals in kind, however, were so unpleasant that the practice was abandoned by mutual consent.

In Camp.—The British have found that in all cases urine is best disposed of by soakage-pits. Feces can well and economically be disposed of by incineration if the following two points are observed, viz.: (a) the proper amount of absorbent refuse, and (b) the proper type of closed incinerator.

[*B*] "A battalion of standard strength of 1,000 men provides 600 lbs. of filth a day in the latrine buckets, 500

lbs. of this being liquid and 100 lbs. solid. Normally this is collected in 10 buckets of 60 lbs. each. The fluid in one such bucket is absorbed by 10 lbs. of sawdust, and the regiment thus needs 100 lbs. per day of absorbent matrix of the equivalent value of sawdust, to take up the liquid. . . . Since the total combustible refuse from a standard unit averages 1,500 lbs. per day, the unit should be practically self supporting in its incineration." Stable litter can always be incinerated.

12. Exhumations [*F*].

The French permit exhumations *only* on demand of the public authorities, and for hygienic reasons, as nearness to water sources, wells, or habitations. Exhumations ought always to be performed in cool weather when there are no flies. Before raising the last bit of earth over the corpse, it should be wet down with some antiseptic substance, as creosol or phenol. Occasionally the ditch is filled with water, and the corpses washed there. The exhumed bodies, having been identified, are immediately placed in light coffins and sealed by some bituminous covering. The bodies are then transported rapidly to the cemetery, where new graves should already have been prepared. These are well disinfected with quicklime. Those engaged in the work of exhumation and removal should be protected by rubber boots and gloves, and masks if necessary.

13. Flies.

Both French and British have taken energetic measures to prevent breeding of flies. The procedures are those commonly used, as destruction by poisons and fly-paper, larvacides, incineration of refuse, fly-proofing of quarters and protection of foods.

14. Garbage.

In all the foreign armies, incineration seems to be the accepted means of disposal. The open pit is commonly used in the field. As the methods are similar to those used in the United States Army no comment is made here.

15. Personal Hygiene.

The general measures for the practice of personal hygiene among officers and men is so well understood that mention is made here only of several special points which have been brought out by the present war.

[*F*] *Protection from Cold and Frost-bite.*—Probably the greatest inconvenience and suffering in the trenches, not due to wounds by the enemy, have been caused by cold and frost-bite. These troubles begin by obstruction of sight, difficulty in speaking, feeling of fatigue, rigidity of muscles of the head and neck, weak pulse, finally suffocation and death. Occasionally men fall over suddenly and die.

Prophylaxis consists in abundant nourishment, with foods rich in fats, warm drinks and tonics, as tea, coffee, warm sweet wine. Alcohol (as whiskey) should not be given in the smallest dose. Clothing is important, and it is better to put on additional light impermeable clothing, than to wear heavy clothing in smaller quantity as the latter constricts the muscles and circulation. When on guard it has

been found possible to practically button up two men in an impermeable coat of rubber, or some similar substance, the men keeping warm by their own bodily heat which cannot escape.

Treatment of general stroke from cold is to take the patient to a *cool* room (never near a fire), lay him on straw, open the windows, undress him, and rub him vigorously with snow or a wet cloth. Practice artificial respiration, inject diffusible stimulants as ether or oil of camphor. When the patient shows signs of returning consciousness, give a rubbing with alcohol, shut the windows, then administer a warm and slightly alcoholic drink.

To protect the hands from the extreme cold of the trenches gloves, even when lined with fur, are not sufficient. Thick woolen mittens, with place for thumb and forefinger (for use on gun) separate, are best. Then the forefinger can be pulled back and warmed by contact with the other fingers when not in use. Very severe sores, often ulcerating and exhibiting gangrene, may occur from neglected frost-bites. Above all frozen hands or feet *should be kept away from the fire.*

Probably the greatest inconvenience in the trenches has been from frost-bite on the legs and feet. Both English and French armies have suffered severely and lost the equivalent of regiments of men from this cause alone. The term "frost-bite" is really a misnomer, as continued exposure of the affected part to cold water is the chief cause rather than actual freezing. So severe are these "frost-bites" that the loss of a leg or the enforced amputation of a foot are not at all infrequent.

To prevent frost-bite the following should be observed: avoidance of tight puttees; large, roomy, well-greased boots; two extra pairs of boots, two pairs of woolen socks frequently changed, felt or paper lining for boots, and, best of all, dry trenches. The British claim that the essential factor in "frost-bite" is prolonged contact with cold water, and that "superficial areas of gangrene are produced by the mechanical obstruction to surface circulation by imbibition of water by the skin during long standing in trenches."

Personal Cleanliness.—In theory at least the French insist much more strongly than the British upon the cleanliness of the soldier. More than once a day he is required to wash hands and feet, clean nails and comb hair. Mouth and teeth are washed, in the absence of a brush, with a soap solution and then rinsed. There should be a daily bath (see under Baths) or, lacking this, those parts of the body subjected to chafing on the march should be carefully washed. At least every week the men are required to take a shower bath. The soldier is also required to frequently wash his clothing.

For clothing the soldier should wear woolen undershirt and drawers, heavy if in cold weather, light if in warm, but always woolen. The shirt should be long enough to double up at the bottom over the stomach, as, according to the French, it is efficacious in preventing digestive troubles and diarrhea caused by cooling of the stomach. At least once a week underclothing should be washed. Where washing is being done, either a constant flow of water or frequent sterilization should

be secured. To wash without shrinkage, blankets should be dipped rapidly in boiling water, rapidly washed in warm water, and rapidly dried without wringing.

The care of the feet is of first importance, and every regiment should have at least one expert chiropodist. Boots must be large enough to wear in them two pairs of socks, that nearest the skin being woolen. Boots should be oiled every night inside and out (castor or cod-liver oil is satisfactory) and two pairs are advisable if possible. Socks should be clean each morning, or if this is not practicable, they should be aired and turned inside out. When at a halt it is well to unlace or take off the boots. The French find a leather strap, outside the shoe, brought once around the lower part of the ankle, thence under the instep and buckled just on top of the instep (a figure 8 around the instep) to be of great help in easing the foot while marching. All blisters should be pricked at the end of the day, and they, together with any sores, painted with tincture of iodine [*B*] or a commercial formalin solution [*F*]. For corns, daily bathing in a solution of salicylic acid (60 grains), extract Cannabis Indica (8 grains) and flexile collodium (1 ounce) renders them hard and opaque, and in a few days they can be removed.

Water on the March.—This is a very important consideration, as too much or too little water are alike disastrous to the soldier's efficiency. The British consider that the normal average requirements are that the men should get one quart of water at the end of every seven and a half miles marched. The ordinary day's march is 15 miles, hence one refilling of the water bottles will be necessary. To prevent continual pulling at water bottles the men should be given plenty of well-sweetened tea or coffee before starting, and should be encouraged to chew on something (a bullet, pebble, etc.) during the march, as this keeps the mouth closed and hence moist.

16. Rations.

English.—The standard English rations are tabulated below:

	Field Ration.	Reserve Ration.
Protein	175 grams	180 grams
Fat	218 grams	80 grams
Carbohydrates	515 grams	326 grams
Calories	4,855	2,800

Fat has weight for weight, two and one-half times the caloric value of either carbohydrate or protein and should in cold weather be increased at the expense of the carbohydrate.

Sugar is, of course, the most readily oxidized muscle food available. Chocolate, which used to be given to increase the sugar ration, has been found too concentrated a food to be easily digested, and has the further objection of increasing thirst. At present jam, containing 50 per cent. sugar, is given when it is desired to increase the sugar ration.

The British believe in the limited and guarded use of rum in the ration. Two and one-half ounces per man per day are provided at the discretion of the medical officer. The author quoted advises the use of rum when alternative carbohydrates or appetizers as cocoa or soup are not available. It

should only be given in specified amount, at the end of day with main meal and just before men can turn in for their night's sleep.

The standard "tinned ration" of meat and vegetables all stewed together in one tin is recommended to be served at least once a week, as the men are fond of the variety and appetizing flavor.

Fresh meat is best assimilated by use of stew, and the importance of variety in fare cannot well be overestimated.

French.—The French standard field ration gives a caloric value of 3,064, while that of the English is 4,855 (see above), that of the Russians 4,190 and that of the Germans only 2,801. The latter is considered inadequate and must have been supplemented considerably during the present war. The "Practique de l'Hygiene" does not give the calorific values of the several constituents of the ration, but goes in great detail into the weight (in kilograms) of nearly every element to be found in the daily ration. Detailed rules are also laid down for the examination of meat, both on the hoof and after slaughtering. These are rarely found in such books and hence are of value, for the medical officer should have some information regarding all methods of food inspection.

There seems some question as to the propriety, in a book of this nature, of detailed directions for preparing food to be eaten. Thus the proper ingredients for a palatable bouillon are said to be 1 pound of meat, 1 litre of water and 10 grams of salt, the whole brought to a boil and allowed to simmer for four hours. Such directions, running the whole gamut of culinary art, would seem more properly placed in a manual for field cooks, and are too often found in so-called manuals of sanitation.

17. Rats.

Destruction of rats is important in combatting bubonic plague which is carried by the rat flea. The safest poison is phosphorus, made up in 4 per cent. tablets, and sulphur dioxide is effective if it can be concentrated and confined. The French also use both a virus which is ingested by the rats eating treated food, and a toxic extract which is said to be efficacious. The French phosphoric paste is made by mixing 750 grams of flour with 750 grams of water and adding 8 grams of white phosphorus. To the mixture is added 150 to 200 grams of cheese paste and 100 grams of powdered sugar.

18. Stretchers [*F*].

Considerable attention is paid to the design and construction of stretchers. Perhaps the most important point is that stretchers must not be made too cumbersome to navigate trenches and that turns and intersections of trenches must be widened to allow passage of stretchers. See Figures 5 and 6.

19. Vermin [*B*].

The destruction of vermin of various kinds has been treated elsewhere, but it is thought the details of the British method of freeing soldiers from vermin may be of value.

Men are taken in batches, shed their clothing, and pass into a room where there are vats of hot water. The

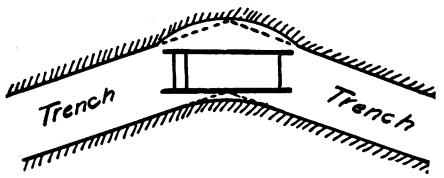


Figure 5

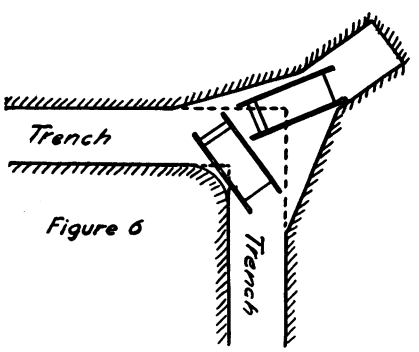


Figure 6

underclothing is removed and put into tubs of strong disinfectant while the men, ten at a time, get into the vats, and wash themselves thoroughly with soap. As water is at a premium, two lots of men use the same water which is thoroughly chlorinated between batches. On emerging from the bath the men rub themselves with lysol soft soap lather, then get rapidly into clean underclothing left by previously treated regiments and which have been sterilized and washed. While the men bathe, an army of women in an adjacent room are ironing the inner seams of the men's outer clothing, into which some lather has been rubbed. The men then dress themselves and march out. Where necessary the heads are washed in a mixture of kerosene and olive oil and the hair clipped.

20. Voluntary Infection [*F*].

The French note that cases are not infrequent where soldiers, in order to escape their military obligations, will voluntarily expose themselves to infection, or, being ill with one disease, will attempt to contract another. Such cases are treated summarily by court martial as deserters or for insubordination. Maladies which are commonly provoked or simulated are:

1. Simulation of jaundice by ingestion of picric acid. Typical jaundice color and reactions are produced. Diagnosis is made by examination of urine for traces of picric acid. Simple examination is made by neutralizing 10 cc. of urine, then making alkaline with one drop of 10 per cent. caustic soda. Add five drops of 10 per cent. cyanide of potassium and on warming a red color appears if picric acid is present.

2. Provoked Conjunctivitis. This is attained by means of irritating powders as tobacco, ipecac, tartaric or boric acid introduced under the eyelid. The soldier explains his ailment by exposure to cold, irritating gas, etc. Diagnosis is only made by examination of his effects and discovery of ipecac, boric or tartaric acid.

3. Simulated Erysipelas. This is accomplished by rubbing the face with some irritating salve. Diagnosis is made by absence of fever and systemic reactions.

4. Provoked Abscess. This is effected by subcutaneous injections of kerosene, gasoline or turpentine. Diagnosis is by noting sterile character of pus, odor of the injected substance,

and chemical analysis of pus. Examination of the suspects' belongings brings to light the responsible agent.

5. Simulated Itch. Produced by pricking the spaces between the fingers with a needle and rubbing with salt. There are other simulated affections, but those given above are in greatest favor.

6. Venereal Disease. As has been stated elsewhere, there has been a very considerable increase in the frequency of venereal disease among the soldiers during the progress of the war. Some part of this increase has been attributed to voluntary infection by men who wish to get themselves invalided away from the trenches.

Men also sometimes refuse treatment or operation in the hope of prolonging their illness. Such cases must be treated according to the law of the land and as severely as possible. In addition soldiers may voluntarily wound themselves, either by shooting themselves in the hand or foot with captured weapons or even their own, or by voluntarily producing "accidental wounds" from machines, tools, gun mechanism, etc.

21. Water Supply.

Both the French and British manuals devote considerable space to the investigation of sources, supply, and purification of drinking water. That which is presented below gives the more important or novel features from both sources, that from the French being prefixed by a bracketed *F* and that from the British by a bracketed *B*.

[*F*] It is recognized that physical character of water is not an index of its purity, and that in judging of the purity of a water the following facts should be noted:

(a) Physical character (odor, taste, turbidity, etc.);

(b) Conditions under which it is received, collected, and distributed;

(c) Knowledge of the geologic character of the region both above and below ground. Regions of limestone or fissured rocks are always suspected;

(d) Chemical and bacteriological examination.

All waters which are not, or cannot from lack of facilities, be given a clean bill of health by a laboratory analysis, are suspected and are sterilized until proven pure. The French standards are give in Table I. In general they are lower than American standards.

[*B*] Bacterial and chemical examination in the field has been unheard of until the present war, but now motor laboratories are provided in which routine examination may be carried on. These complete laboratories are not sufficient to meet all needs and for reconnaisance portable boxes have been devised, containing necessary equipment to determine total number of organisms and minimum amount containing lactose-fractors for 16 samples per day. Eight test tubes are provided for each water—one of agar for the total count and seven of McConkey's taurocholate-lactose-litmus broth in amounts ranging from 0.5 cc. to 20 cc. The box contains also necessary incubator and sterilizer. All accessories and materials for examination of 500 samples are carried in another box. The total weight is little over 100 lbs.

TABLE I.

SIGNIFICANCE OF VARIATIONS IN COMPOSITION OF WATER.

(In p. p. m.)

	Very pure water.	Potable water.	Suspected water.	Bad water.
Total permanent hardness.	5–15	15–30	>30	>100
Hardness after ½ hr. boiling	2–5	5–12	12–18	over 20
Saline residue (after 4 hours hours @ 110°C.)	<150	<400	400–700	>700
Chlorides as NaCl	<27	<66	85–165	>165
Chlorides as chlorine	<15	<40	50–100	>100
Sulphate as anhydrous $CaSo_4$	3–8	8–50	50–75	>85
Organic materials (as oxygen consumed by permanganate per million parts alkalinity)	1	2	3–4	>4
Nitrates	0	0–15	15–30	30
Nitrites	0	0	trace	appreciable quantity
Albuminoid ammonia	0	.05–0.10	0.11–0.15	>0.15
Bacteria	0–100 per cc.	100–1,000	1,000–10,000	>10,000
B. coli	0	1–10 per litre	10–50 per litre	>50 per litre

<=less than >=greater than.

and examination of 16 waters per day is possible. Table II shows the results

TABLE II.

BACTERIAL EXAMINATION OF WELL WATERS IN RURAL DISTRICTS.

Class.		Total organisms per cc.	Least amount containing lactose fractors, cc.
Springs	(1)	50	39
	(2)	100	9
Wells	(1)	25	50
	(2)	70	5
	(3)	140	2.5

of examinations of 290 waters from three classes, as follows:

Class One.—Fully protected.

Class Two.—Imperfectly protected, but having no source of pollution within danger zone (taken as 30 feet or more for wells). This is better taken as 100 feet in the United States.

Class Three.—Imperfectly protected and having source of pollution within danger zone.

The whole value of this table lays in the compilation of average figures, to which a given examination may be referred and its relative degree of pollution indicated.

[*B*] *The water requirements of a military force are:*

(a) Each man requires per day the following:

In barracks	20 gals.
In standing camps, when clothing is washed	5 "
In camps, when no clothing is washed	3 "
In bivouacs, for drinking and cooking only	1 "
For drinking only, as a minimum	3 pints
During the march (of 15 miles per day)	1 gal.

(b) The daily requirements for animals are:

Horse or camel	10 gals.
Ox	8 "
Mule	6 "
Donkey	5 "
Sheep or pig	2 "

[*B*] *To estimate the yield of a well,* lower the water level rapidly by pumping; then note the time to refill. Area of well = .785 (nearly $\frac{3}{4}$) × square of diameter. Cubic contents pumped out = area × depth refilled. Cubic contents × 6.23 (nearly $6\frac{1}{4}$) = no. Imperial gallons* yield in noted time of refilling. (Express results in gals. per 24 hrs.) To find yield from streams, get surface velocity from floating chip over measured length. Take four-fifths of this as mean velocity. Multiply this by sectional area to get discharge.

[*B*] The most likely place for water in hilly districts is the base of the steeper side of a deep valley, just below where the valley bifurcates. The most likely situations in a plain are the lowest depression and points where vegetation shows greenest, or the morning mist hangs longest, or the midges are most numerous.

Not the least valuable contribution of Lelean's "Sanitation in War" is a brief sketch of the geological formations of Northeastern France and Belgium in relation to the water supply. Such information is so difficult to obtain and may be of such immense importance to American troops that the salient features are reproduced below.

The area is divided into four geological districts. A plan of these is shown in Figure 7 and sections in Figure 8. Briefly the characteristics of the districts are as follows:

Area A. The limestone on top is fissured, and the resulting springs and wells are likely to be grossly contaminated. The underlying gravel yields pure water, but often of high color due to iron and organic remains.

Area B. The gravel yields abundant water, retained by the impervious underlying clay. The chalk where outcropping on side hills, etc., is fissured and allows water to percolate so rapidly that it is useless to bore for water on the higher chalk hills. The alluvial deposits in the lowlands are water-bearing, but often contaminated by manured lands.

Area C. The surface gravels are water-bearing, but the water is often heavily polluted and must usually be purified before drinking. The sand dunes toward the coast often yield water in wells driven in the center of the dune. The yield of such wells may

* Multiply by 7.48 (or $7\frac{1}{2}$) to get United States gallons.

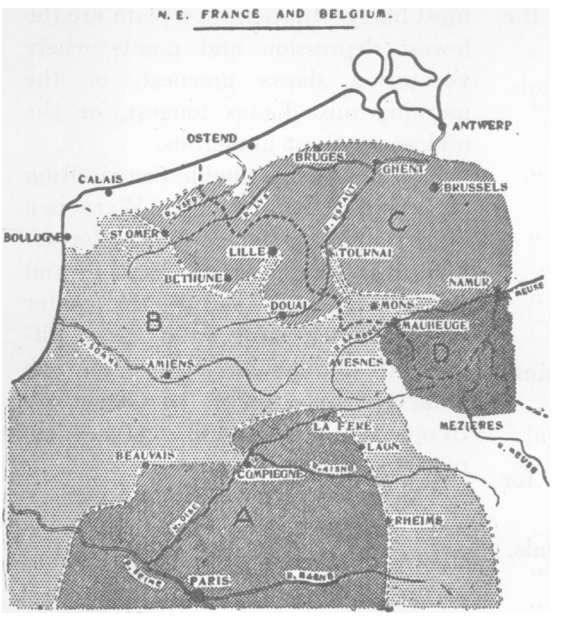


FIGURE 7

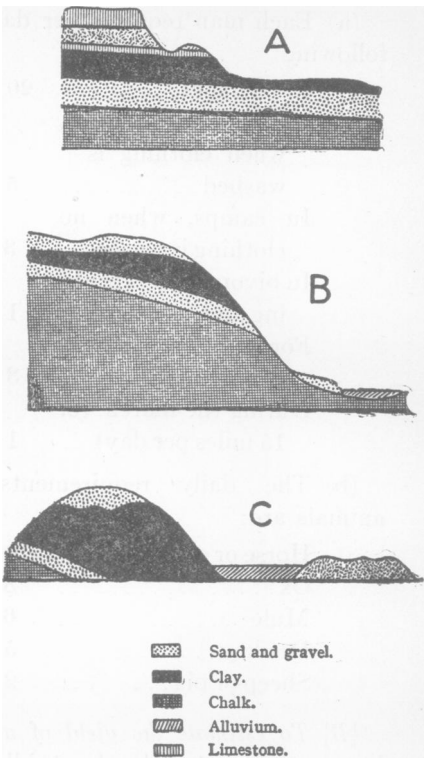


FIGURE 8

be increased by radial feeding trenches filled with stones and covered.

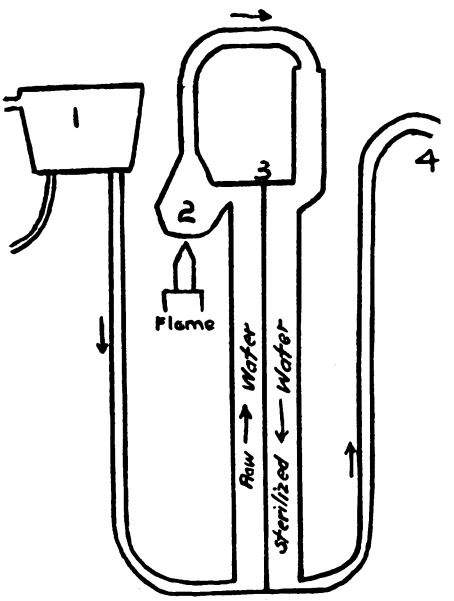
Area D. A mountainous region of limestone and chalk yielding a pure water readily obtained.

It is noted that the water supply of most Belgian towns has always been unsatisfactory and often from polluted sources. For this reason the advance of the Allied forces into Belgium is likely to lead to grave questions of water supply and purification for both civil and military populations.

22. Water Purification.

Heat.—The simplest and most efficacious method is by boiling, and this is done in all temporary encampments. It is often best to make the water into weak tea which is a better thirst quencher and more palatable than boiled water. On the march British practice is to boil the water in kettles during the night. The water bottles are then filled and hence sterilized. A second boiling provides enough for the water carts. In the morning the unit moves with bottles full and carts containing refill for bottles, all water (or tea) being cool and sterile.

The most economical means of heat sterilization is by some apparatus whereby the heat of the outgoing sterilized water is given up to the incoming raw water. An apparatus similar to the Forbes-Waterhouse sterilizer in use in the United States Army has been used by the British but has been found unreliable, since the middle compartment may leak and raw



Forbes-Waterhouse Sterilizer

Figure 9

water get into the outgoing stream without detection. The principle is shown in Figure 9.

Filtration.—In the United States Army, in large encampments of a more or less permanent nature, the Darnall filter is used. This consists of a series of containers, holding in all 20 gallons. There is siphon action, whereby the water is treated with alum and sodium carbonate (1 lb. per 500 gals.). Most of the suspended matter and a large percentage of bacteria are thus precipitated, and the water is filtered through flannelette bags. The apparatus is heavy and cumbersome, and what purification there is, is mechanical only.

Where the ground is at all adapted to filtration, the British have evolved rather elaborate means of collecting water by building a revetment parallel to a side hill contour, siphoning the water into this from a nearby stream, and filtering it. The filtered water may then be delivered under some head. See Figure 10.

The British also advocate the use of the self-washing filter cone, such as is used at Toronto. Theoretically it is most economical but no results from its use in the army are given, and it has not been satisfactory at Toronto.

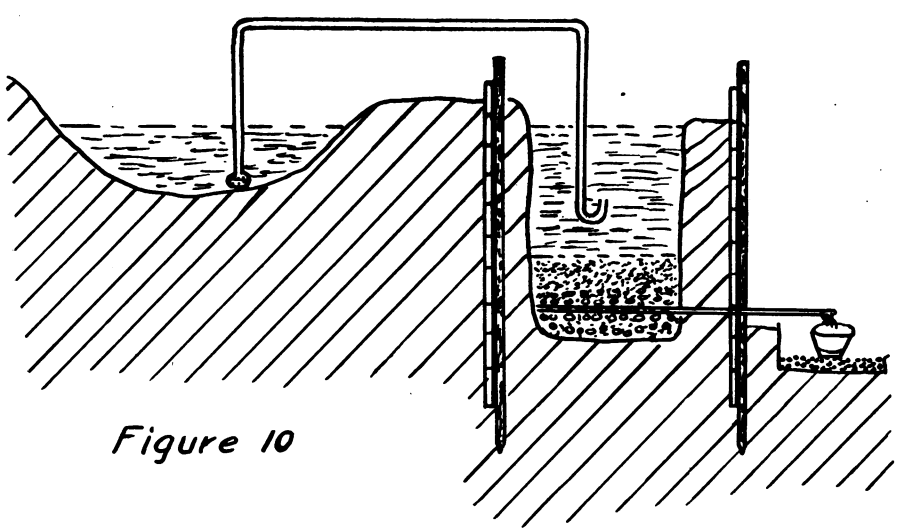


Figure 10

The British and French both use "filter candles" of porcelain or prepared material. The use is limited and results are not altogether satisfactory.

Chemical Sterilization.—When all is said and all the various suggested methods of water purification have been tried, sterilization by means of chemicals has been found most satisfactory. Of all the possible chemicals which have been used bleaching powder, or hypo-chlorite of lime has been found the most desirable, and the other chemicals largely discarded in its favor.

Hypochlorite of Lime.—To insure adequate sterilization there should be one part of available chlorine per million parts of water. To allow for probable deterioration of commercial bleaching powder, a safe amount to use is 2 grams per 110 gallons. (The British water cart holds 110 gallons.) Standard practice is to use 30 grains per 100 gallons or 8¼ pounds per million gallons. Convenient factors are that one gram = 15.43 grains, that one gallon = 70,000 grains, and that one thousand grams = 2.2 pounds.

[*B*] To determine roughly the amount of available chlorine in bleaching powder, proceed as follows:

(1) Make a thin paste from ten grains of bleaching powder and distilled water.

(2) Add one gram of potassium iodide freshly prepared.

(1) Oxidizing action. Use of a powder the base of which is permanganate of potash. Use .5 grains for 2 litres. Allow the treated water to stand 30 minutes. It should have a faint rose color.

(2) Reducing action. Accomplished by the use of a reducing agent, the active principle of which is hyposulphite of sodium. The same volume as of the oxidizing agent is used. On stirring the color becomes yellowish brown. This finally turns black and there is a precipitation of manganese dioxide with consequent clarification. The clarified water is then filtered through the Garret filter, the operation of which is evident from Figure 11.

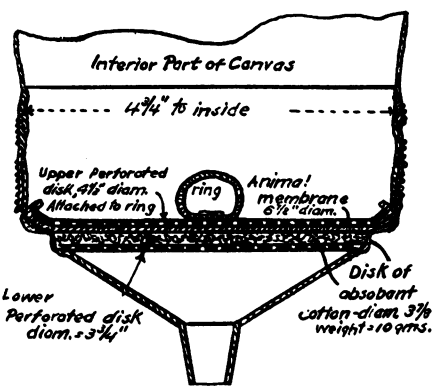


Figure 11

Constant care to clean and sterilize the cotton filter is necessary. Otherwise the bacteria grow there and the treated water may be worse than the raw water. Used with care the apparatus is said to give excellent results, especially where both turbid and impure waters have to be handled.

The English do not advise the use of permanganate of potash alone, stating that its effect upon other than cholera organisms is uncertain, and that in addition it leaves color and taste. They do not mention its use in connection with sodium hyposulphite.

The English tendency is to use alum

for clarification, and hypochlorite for subsequent sterilization, and in this they probably accord with American opinion. It is necessary to point out that English alum is potash alum of formula

$$Al_2(SO_4)_3 + K_2SO_4 + 24\ H_2O$$
$$343 + 174 + 432 = 949$$

molecular weight, whereas American water supply alum lacks the potash. Using potash alum 5 grains of alum and 1½ grains of sodium carbonate are the amounts needed for a gallon of water—roughly a heaped tablespoonful of alum per 100 gallons and one-third as much sodium bicarbonate. The Darnall filter, mentioned above as in general use by the United States of America, utilizes similar methods.

To provide a simple, light, efficient apparatus for water purification and one easily erected, the Lister bag has been devised by the United States Army. This is a heavy canvas bag, supported on a tripod. Five spigots are set in the bottom with their ends projecting about three inches above the bottom of the bag. Five soldiers at a time can thus use the bag. The bag is suspended and filled with water, which should be clear. To the water is added in the form of a paste 1 grain of calcium hypochlorite. The chemical comes in glass tubes containing 1 gram each. The bag holds 40 gallons of water. The disadvantage of the bag is that while it sterilizes it does not clarify. The ideal arrangement is said to be the Darnall filter used in conjunction with the Lister bag.

[*B*] *Sodium Bisulphate.*—This salt provides a most useful means of sterilizing water by the use of a single tablet, and is in considerable use by the British. It affords a valuable means of sterilizing water for troops—as cavalry, which occasionally find themselves detached from their water carts. Each cavalry man should carry a bottle of tablets, and when refilling his water bottle he should add a couple of tablets and abstain from drinking for a half hour. Addition of 2 grams of the salt to the contents of an (English) water bottle gives .07 per cent. free H_2SO_4 which destroys bacteria in one half hour. The tablets are made up with oil of lemon and saccharin so that the solution tastes like lemonade. The objection is the liability to formation of soluble sulphate of toxic metals from water bottles. Nearly all alloys and metals are attacked. Aluminum water bottles should be supplied to all men using these tablets as the aluminum sulphate formed is so slight as to be of no consequence.

Chlorine Gas.—The use of liquid chlorine and the production therefrom of chlorine gas has come to have a widespread and satisfactory use in the United States. It seems probable that this method of sterilization will supplant older methods for permanent or semi-permanent encampments, at least in this country.